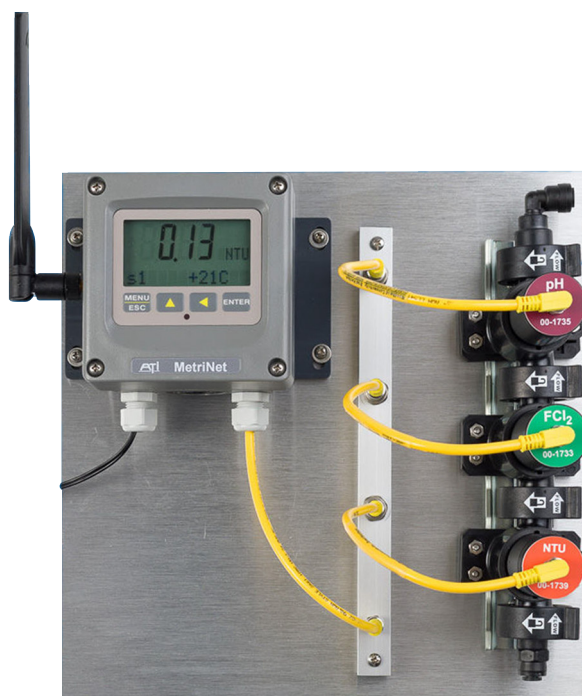




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INTRODUCTION

General

The Q52/MetriNet cellular communications option allows users to send secure measurement data to websites or other servers via the integral LTE-M cellular radio. Like all of the communication options for the Q52/MetriNet controller, the LTE-M cellular radio feature can be installed as the optional digital output communications card inside the Q52 enclosure. Due to consideration for the antenna mount through the enclosure wall, cellular radio versions of the Q52 are specifically built and fully tested at point of order. In locations where cellular radio signal strength may be weak or intermittent, an optional remote antenna can be used to improve the data connectivity.

This operating manual specifically covers the features and operation of the cellular option feature. For basic operation of the entire Q52/MetriNet panel and sensors, refer to the *“MetriNet Q52 Controller”* user manual.



Figure 1: Q52/MetriNet system with three M-Node sensors

Q52/MetriNet Cellular Remote Antenna Extension Mounting (Optional)

If the Q52/MetriNet is equipped with the optional cellular modem and the system is located in an area with weak cell service, an antenna extension kit (part number 05-0163) is available to locate the antenna in a more optimal location for cellular connectivity. This kit is ideal for systems mounted in a basement or a vault that is below grade. The extension kit includes an antenna that can be mounted indoors or outdoors, a mounting bracket, an adapter and 30 foot (9.1 m) cable. [Figure 2](#) shows the components, connections and bracket mounting hole pattern.

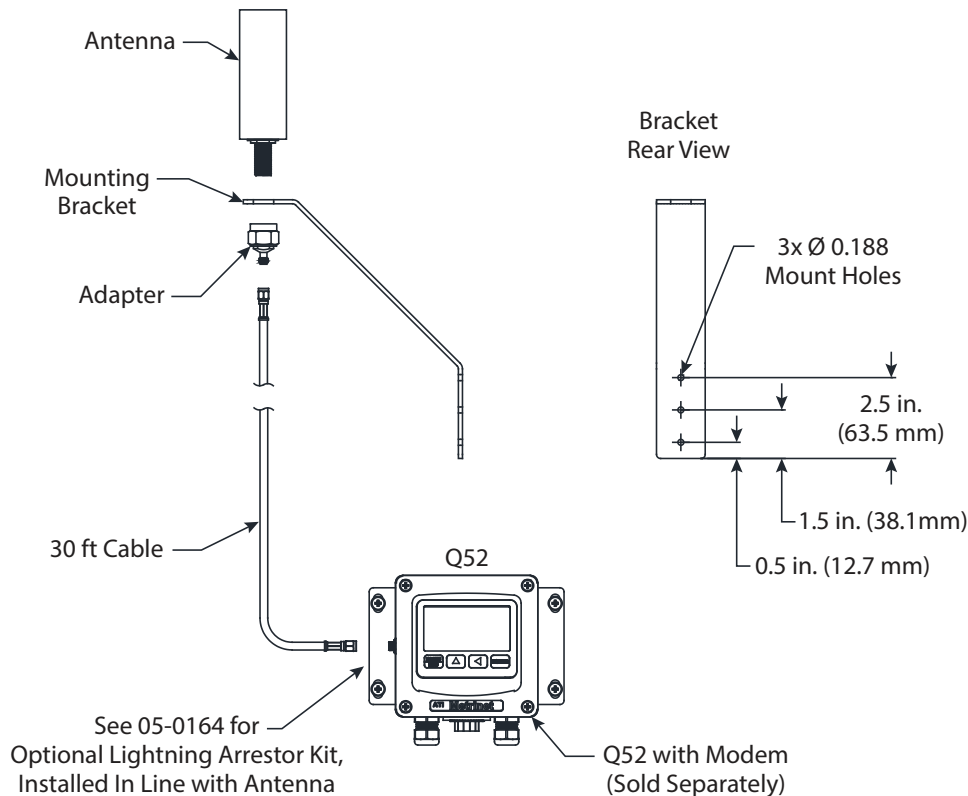


Figure 2: Antenna extension kit

A lightning arrestor kit (part number 05-0164) is also available if the antenna is mounted outdoors in a vulnerable location. This kit (shown in [Figure 3](#)) includes a lightning arrestor and an additional 30 foot extension cable. It is recommended that a grounding cable (customer supplied) be connected to the arrestor.

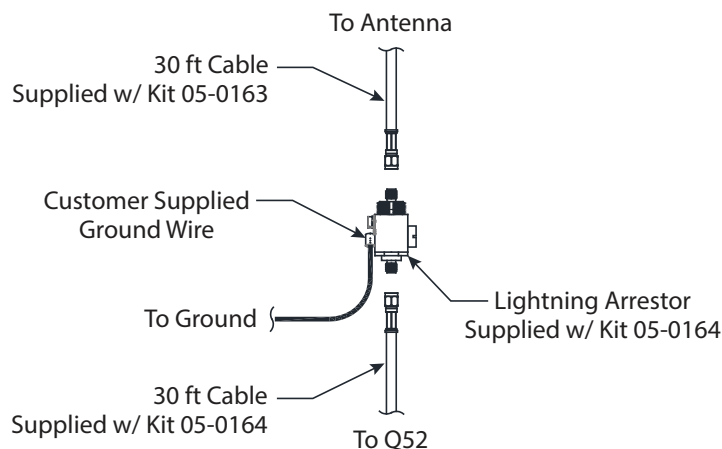


Figure 3: Optional lightning arrestor kit

Q52/METRINET OPERATION

General

Q52/MetriNet systems come preconfigured, pretested and connected to your BEACON® cloud data account. There are only a few system configuration settings required to install and run.

NOTE: This manual is specific to cellular option operation. Refer to the “*MetriNet Q52 Controller*” user manual for installation, basic operation and sensor setup and calibration.

The following Q52/MetriNet cellular menus are specific to the cellular modem feature and are adjustable. See [Figure 4 on page 6](#). The *OPTIONS* menu contains all Q52 settings related to the data logging function and the internal cell modem.

Basic Q52/MetriNet Cellular Communication Setting for Data Upload

Host Comms	Enables internal cell modem or other digital communications interface. A cellular unit should come factory set to Cell . Make sure the setting remains Cell .
Xmit Start	Defines when the first data transmission by the cell modem occurs. Range is 00–23, 00 = midnight, 23 = 11 PM
Xmit Intval	Sets the interval between cell modem data transmissions.
GPS Entry	Allows manual entry of latitude and longitude Data.
Lat Degrees	Range is 0–90. Enter the first two digits (DD) of the latitude. Format for latitude is DDMM.MM N/S.
Lat Minutes	Range is 00.00–99.00. Enter the next four digits (MM.MM) of the latitude.
Lat N-S	Enter N for North, enter S for South.
Lon Degrees	Range is 0–90. Enter the first three digits (DDD) of the longitude. Format for longitude is DDDMM.MM E/W.
Lon Minutes	Range is 00.00–99.00. Enter the next four digits (MM.MM) of the longitude.
Lon E-W	Enter E for East, enter W for West.
RSSI	Received Signal Strength Indication, displays the Received Signal Strength Indication (RSSI) as a decimal value represents a measure of how strong the radio signal is that the Q52 MetriNet Cellular Modem receives from a wireless access point.
BER	Bit Error Rate, displays the Bit Error Rate (BER) as a decimal value that represents the number of bits received in error relative to the total number of bits transmitted.

Logging Settings

Log Mode	Turns the data logger on or off and defines whether logging is continuous or that it stops when memory is full. If the data logger is shut off, the modem is disabled.
Log Intrval	Sets the data storage interval. Range is 0.1–99.9 minutes.
Unit Addr	This number is part of the data log file name that is uploaded and is used to identify the controller that supplied the data. It is also used as the Modbus address if the unit is connected to an external Modbus network. Range is 1–247.
Clear Log	This routine clears all data stored in flash memory as well as the data that is held in the cell modem flash memory. Once cleared, it cannot be recovered. Verify that all data has been saved (or is not needed) prior to clearing the log.
Alarm Enable	Enables uploading the <i>Alarm Log</i> record.

Measurement Settings

Valve Delay	If the optional solenoid is used to turn flow on and off, <i>Valve Delay</i> defines the delay time, starting from when the solenoid is opened, before sensor nodes are powered up to make measurements. Delay time depends on length of sample lines. Delay may be set from 1–99 seconds.
Sensor Delay	When in <i>CYCL</i> mode, <i>P-U Delay</i> defines the time period after the nodes are energized until the controller polls the nodes for data. Range is 1–99 seconds.
Poll Rate	When in <i>CYCL</i> mode, defines the rate at which data is recorded. In other words, this is the cycle rate. Range is 1–60 minutes.

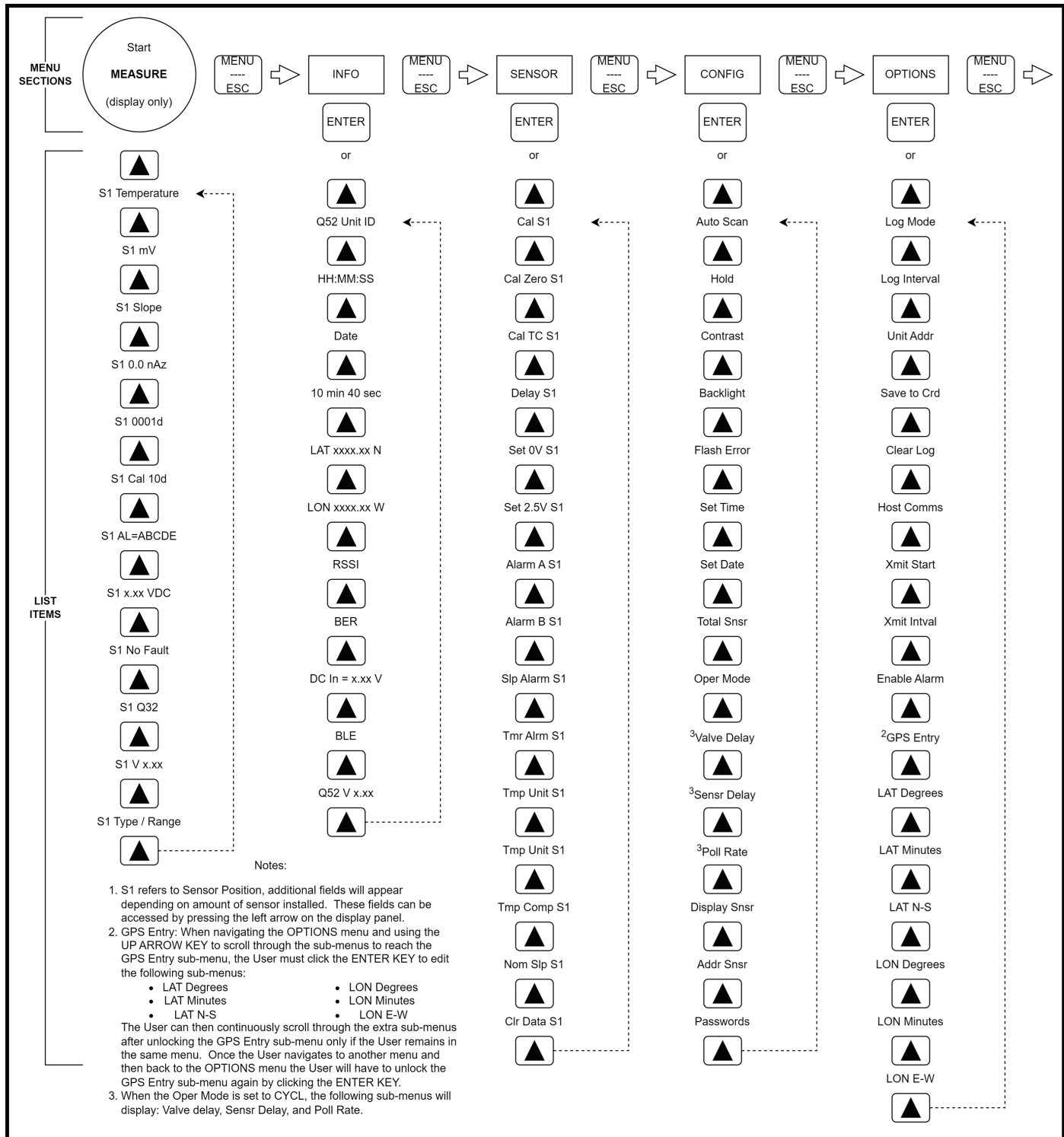


Figure 4: Menu structure

Signal Strength

Allows the user to have a visual representation of the Signal Strength displayed on the Q52 MetriNet Cellular Modem display as Received Signal Strength Indication (RSSI) and Bit Error Rate (BER).

RSSI	Received Signal Strength Indication, displays the Received Signal Strength Indication (RSSI) as a decimal value represents a measure of how strong the radio signal is that the Q52 MetriNet Cellular Modem receives from a wireless access point.
BER	Bit Error Rate, displays the Bit Error Rate (BER) as a decimal value that represents the number of bits received in error relative to the total number of bits transmitted.

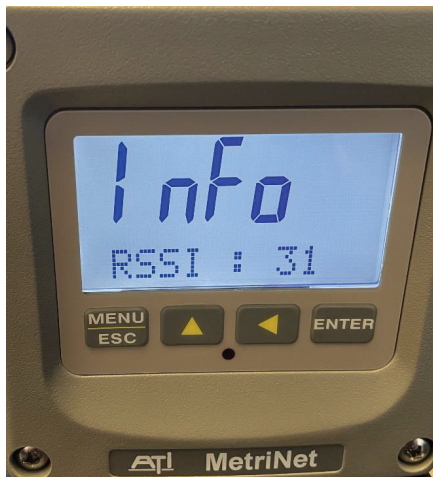


Figure 5: Q52 RSSI screen

Signal Quality Received Signal Strength Indication (RSSI)

Values	RSSI dBm	Condition
0	-113 or less	Marginal
1-9	-111 to -95	Marginal
10-14	-93 to -85	OK
15-19	-83 to -75	Good
20-30	-73 to -53	Excellent
31	51 or greater	Excellent
99	"Unk"	"Not Known" or "Not Detectable"

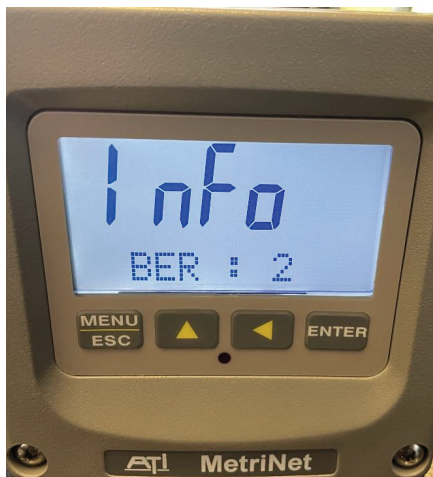


Figure 6: Q52 BER screen

Signal Quality Bit Error Rate (BER)

Values	Description	Condition
0	Less than 0.2%	Best
1	0.2% to 0.4%	Best
2	0.4% to 0.8%	OK
3	0.8% to 1.6%	OK
4	1.6% to 3.2%	OK
5	3.2% to 6.4%	OK
6	6.4% to 12.8%	Marginal
7	More than 12.8%	Marginal
99	"Unk"	"Not Known" or "Not Detectable"

BEACON CLOUD ACCOUNT DATA

General

The Q52/MetriNet cellular controllers are preconfigured at the factory to be connected to the your data account on the BEACON® cloud data site. The system should run out of the box, but you may need to configure the synchronization of sensors in some cases – or at least check them.

Sensor Data and Display

The order of the sensors shown on the local Q52/MetriNet device display and the order of the same numbered sensors entered in the BEACON® account must match. So, as you number and install sensors manually in the Q52/MetriNet controller as S1, S2, S3, note which sensor is each “s” parameter designator, and verify it matches the same “channel assignment” in the BEACON® account. S1 = Channel 1. Refer to the M-Node assignment in the *“MetriNet Q52 Controller”* operating manual.

On the BEACON® cloud site, the order of the connected sensors can be seen and modified by selecting the *Device Name* of interest, then clicking **Edit** or by right-clicking the **Device Name** and selecting the *Edit Sensor* option. Temperature is always first and assigned to channel 0—this value always comes from the sensor at S1. Sensors can be added by clicking **Add Sensor** and inputting the *Sensor Type*, *Channel*, *Units*, *Y-axis Max* and *Y-axis Min*. Individual sensors can be deleted by clicking the trash can icon on the far right. If any changes are made, click **Save** at the bottom of the page.

NOTE: For systems that include conductivity as part of a multi-node assembly, it is best to put the conductivity sensor in the first flow chamber and assign it to Channel 1. If systems contain conductivity and turbidity, then turbidity should be assigned to Channel 1 and inserted into the first flow cell, followed by the conductivity node. All other parameters can then be assigned in any particular order.

Connected Sensors

Sensor Type	Temperature	Channel	0	Units	C	Y-axis Max	60	Y-axis Min	0
Sensor Type	Conductivity	Channel	1	Units	uS	Y-axis Max	500	Y-axis Min	0
Sensor Type	ORP	Channel	2	Units	mV	Y-axis Max	10	Y-axis Min	0
Sensor Type	Pressure	Channel	3	Units	psig	Y-axis Max	150	Y-axis Min	0
Sensor Type	Fluoride	Channel	4	Units	ppm	Y-axis Max	10	Y-axis Min	0.1

Add Sensor

Figure 7: BEACON connected sensors

Location Information

For each MetriNet system, the location information can be updated from the *Edit* menu as desired. If entered, the *Location Name* displays on the main *Sensor Asset* page. When the *Latitude* and *Longitude* values of the unit location are entered, the map viewport displays the location.

Location Information

Location Name

Address Line 1

Address Line 2

Address Line 3

City

State/Province

Select... ▼

ZIP/Post Code

5 or 9 digits no hyphen for US, A1A 1A1 with space for Canada, no restrictions otherwise.

Latitude

Negative for South of the equator, positive for North.

Longitude

Negative for West (North America), positive for East (Europe/Asia).

Figure 8: BEACON location information

Configure Events

An event or notification with detailed conditions can be configured within BEACON® for any sensor. To create an event, navigate to the desired device from the *Assets* page in BEACON®, then scroll down to the *Configure Events* section. Select the *Set Up Events* option then select the sensor channel, enter a name for the event and set the conditions, schedule and date range as desired. To receive notification when the event conditions are triggered, additionally enter an email address under the *Subscribe* heading. Click **Save**.

When the conditions of the event are met, the name of the event appears under the *Active Events* heading and, if configured, an email notification is sent.

NOTE: If immediate notification is desired, enter the same conditions of the event as Alarm A or Alarm B for the sensor on the Q52. This activates the *Enable Alarm* setting from the *Options* menu.

LOGGER DATA, ALARM AND EVENT LOG DATA (RAW DATA)

General

Much of this information is provided only for information purposes, as data uploaded to the BEACON® cloud site is automatically configured. The information provided here is for when you are sending data to other clouds or servers, or simply viewing raw data inside BEACON® or data on the SD card.

The primary purpose of a cellular Q52/MetriNet system is to monitor water quality parameters, log the data, and then periodically upload that log to a server or cloud. As a protective backup, the data can also be offloaded locally through the use of the SD RAM card feature located in the controller. The amount of data depends on the number of sensors used and the logging frequency. Refer to the "[MetriNet Q52 Controller](#)" user manual for more details on the SD RAM card.

Data File Format

Data is stored internally to the Q52/MetriNet and is transmitted in a standard .csv format. Once off-loaded, data can be easily displayed and analyzed using Excel or other spreadsheet programs. Shown on the next page is part of a typical data file that has been sent by modem to a storage cloud data site.

When sent to an FTP site, the actual data file name includes unit ID and time stamp to show when and where the file originated. The format of the file name is Data_Dev_ID_YYMMDD_HHMM where Data indicates it is a data file as opposed to an alarm file, Dev_ID is the unit address number, Date and Time as entered in the Q52. Time is in 24-hour format.

Other information included in the header of each data file includes:

- **The Radio Model number**, 16-digit Radio IMEI number, and 20-digit SIM card number.
- **The Signal Level and Bit Error Rate** indicates reported radio signal strength. A value of 10 or more is typical, a signal level less than 10 may still connect, but may take longer to send data or intermittently have problems calling out.
- **The Supply Voltage** is the measured DC voltage powering the Q52. For battery powered systems, this provides you with an indication of battery charge status and can be used to know when it is time to change out or charge a battery pack.
- **The Latitude and Longitude** displays the physical location of the unit.

Stored Raw Measured Data Format

All data is stored as 16-bit data with 4 decimal resolution. In order to convert raw data to actual engineering units, divide each value by 1000. Since each controller can accommodate up to 8 nodes, a 0 value is stored for each unused sensor input. Data manipulation such as appending files and generating graphical reports is left to you.

Date Record										
Radio Model	HE910-D									
IMEI Number	35613607	4512551								
SIM Number	89011702	27202478	6805							
Signal Level	11									
Bit Error Rate	3									
Supply Voltage	12.1									
Latitude	5453.34N									
Longitude	8531.52W									
Date	HH:MM:SS	Temp	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6	Sensor 7	Sensor 8
9/23/2018	15:10:58	26040	2374	7000	13040	1000	0	0	0	0
9/23/2018	15:25:58	26130	2368	7000	13030	1000	0	0	0	0
9/23/2018	15:40:58	26190	2364	7000	13030	1000	0	0	0	0
9/23/2018	15:55:58	26410	2349	7000	13040	1000	0	0	0	0
9/23/2018	16:10:58	26430	2348	7000	13020	1000	0	0	0	0
9/23/2018	16:25:58	26600	2336	7000	13000	1000	0	0	0	0
9/23/2018	16:40:58	26640	2334	7000	12990	1000	0	0	0	0
9/23/2018	16:55:58	26700	2330	7000	13020	1000	0	0	0	0
9/23/2018	17:10:58	26670	2332	7000	13020	1000	0	0	0	0
9/23/2018	17:25:58	26640	2334	7000	13020	1000	0	0	0	0
9/23/2018	17:40:58	26630	2334	7000	13010	1000	0	0	0	0
9/23/2018	17:55:58	26550	2339	7000	13020	1000	0	0	0	0
9/23/2018	18:10:58	26480	2344	7000	13010	1000	0	0	0	0
9/23/2018	18:25:58	26480	2344	7000	13020	1000	0	0	0	0
9/23/2018	18:40:58	26430	2348	7000	13010	1000	0	0	0	0
9/23/2018	18:55:58	26430	2348	7000	13010	1000	0	0	0	0

Alarm File Format

In addition to the data log.csv file, the controller also generates an alarm log file. The alarm file format is similar to the data file format. When copied to the SD card, the file name is *Q52ALnnn* where *nnn* is the unit address number. The alarm file logs an alarm event any time one of the sensor setpoints A or B changes state. If communications are lost to a sensor, "Error" displays. The time stamp shows when the alarm occurred. Up to 200 alarm events may be stored.

While this file is generated as alarms happen, the file is not uploaded via the cellular modem unless menu "Enable Alarm" is ON. If enabled, the MetriNet immediately calls out an alarm and does not wait for the next scheduled upload. Alarm events are handled with very high priority.

To prevent nuisance uploads (excessive uploads) and excessive power consumption, when a sensor alarms, the system does not continue to call in unless an additional sensor alarms. Then, at the regularly scheduled data upload time, the system checks to see if all alarms are cleared, and if so, the system resets to call in again at the first alarm. The logic of alarm management is designed to prevent excessive call-ins that result in high data handling over cellular (excess SIM charges) and also to maintain battery life.

There is an assumption here that any alarm that is uploaded is also immediately acknowledged and acted upon by your data site, as it knows the instant an alarm record appears in the package upload.

Stored Raw Alarm Data Format

Q52 Alarm Record									
Date	HH:MM:SS	Sensor 1	Sensor 2	Sensor 3	Sensor 4	Sensor 5	Sensor 6	Sensor 7	Sensor 8
8/22/2018	1:28:43	OK	OK	OK	OK	0	0	0	0
8/22/2018	21:18:36	A	OK	OK	OK	0	0	0	0
8/22/2018	21:20:58	OK	B	OK	OK	0	0	0	0
8/22/2018	23:09:22	OK	OK	A B	OK	0	0	0	0
8/22/2018	23:23:10	OK	B	A B	OK	0	0	0	0
8/22/2018	23:26:20	OK	OK	A B	OK	0	0	0	0
8/22/2018	20:26:48	OK	OK	OK	OK	0	0	0	0
8/22/2018	20:28:24	OK	OK	OK	Error	0	0	0	0
8/22/2018	21:02:06	OK	OK	OK	OK	0	0	0	0

Event File Format

In addition to the data log file, the controller also generates an event log file. The event file format is similar to the data file format. When copied to the SD card, the file name is *Q52ELnnn* where *nnn* is the unit address number. The event file does not contain a lot of information and many times has nothing at all. However, it is intended to record certain changes as they occur. The following are the events currently stored. Up to 100 events may be stored. This file is not uploaded via cell.

Stored Event Data Format

Q52 Event Record			
Supply Voltage	12.1		
Latitude	GPS Off		
Longitude	GPS Off		
Date	HH:MM:SS	Sensor	Event
9/10/2018	10:57:45	0	EventLog Cleared
9/10/2018	14:33:43	0	Sup Passwd Entry
9/10/2018	14:10:25	0	User1 Passwd Entry

Transmitted Data Package Size

MetriNet controllers are designed to log large amounts valuable data, and then periodically upload that data to a secure cloud data site. The amount of data moved via cellular connection can have an impact on the billable data moved each month by the cellular service provider (SIM). Badger Meter SIMS allow 1 megabyte of data total to be moved each month, but more capability is available if needed.

10 megabytes of data is more than adequate for a typical logging application and is enough to store 8 sensors of data recording every 5 minutes, uploading every 4 hours. The maximum data movement each month for a MetriNet is about 3–4 megabytes – assuming 8 sensors of data is recorded every minute and uploads occur every hour. So, you should consider this during installation as unplanned data “overages” can affect monthly billing rates from some cell service providers.

Every time the MetriNet connects with a data file, the following is an estimate of data transfer:

- 1–2.5K of overhead for each call. This is the cellular connection/registration data
- 2–456 bytes for the info section header of the MetriNet data file
- 3–70 (approximately) bytes per line of time stamped data, for 8 sensors or 44 bytes per line for 4 sensor systems
- If used, multiply the final number by 5 with TLS security engaged

With the minimum of 2.5K of data moved as overhead for the cell connection and no data file, a MetriNet that calls in twice a day moves about 150K of connection/registration data per month ($5K \times 30$) just to establish proper connections. The actual sensor data file size simply corresponds to the number of time stamped entries in the file and the number of sensors recorded.

Below are typical examples, all based on the most common 4-sensor systems.

Example 1

Four sensors of data logged at 15-minute intervals, uploaded every 4 hours. That results in 16 full-time stamped records (lines of measured data) in the data file. There are 6 connections and uploads per day.

- $6 \times 2.5K$ for cell connection each day = 15K of data.
- Each file has 16 lines of data + 456b header, sent 6 times/day – $(6 \times ((16 \times 44) + 456)) = 7K$.
- Each day then equals $15K + 7K = 22K$ transferred.
- A total of $30 \times 22K = 660K$ total data transferred each month.

Example 2

Four sensors of data logged at 5 minute intervals, uploaded every 12 hours. That results in 16 full-time stamped records in data file. There are 2 connections and uploads per day.

- $2 \times 2.5K$ for cell connection each day = 5K of data.
- Each file has 144 lines of data + 456b header, sent 2 times/day – $(2 \times ((144 \times 44) + 456)) = 13.6K$.
- Each day then equals $5K + 13.6K = 18.6K$ transferred.
- A total of $30 \times 18.6K = 558K$ total data transferred each month.

NOTE: Uploading less often greatly reduces SIM data charge as it minimizes the overhead from connection/registration charges of 2.5K per call. Even though the polling rate has increased to 5 minutes, resulting in more data logged, the total data charge per month is less. Even so, both of these cases are well under the standard 1 megabyte per month limit.

POWER CONSUMPTION OF CELLULAR Q52/METRINET SYSTEMS

Q52/MetriNet components are designed to minimize power usage, and the cellular option is most likely to be a battery powered system.

The total amount of power consumed depends on the number of M-Node sensors installed, how often they take a measurement, whether operation is full-power or cycle-power (cycle power is for battery operation), the rate frequency of call-in and whether the controller is 115V AC, 12–24V DC or battery only.

For systems with a cell modem enabled, predicting the exact usage is not possible due to the wide variation in modem power usage based on cellular signal quality. Some guidelines on power usage in the different operating modes follow.

- The MetriNet can be set for continuous operation or for cycled operation in the *CONFIG* menu (“*Cont*” or “*Cycl*”).
- *Cycle* operation is the mode that saves the most amount of power and is the intended mode of operation for battery powered systems. The cycled system sleeps most of the time and only wakes up periodically to take a reading and store data.
- *Continuous* operation is intended for applications where non-battery line power is available and measurement frequency is higher, perhaps every minute.

For a summary on the various general power configurations, see “*General Cellular MetriNet Power*” below.

NOTE: All cases are in “steady state,” so measurements reflect at least 3 minutes after power is first applied. Also, sleep modes only reach low power state if no key has been touched for at least 30 seconds. Touching any key wakes the unit up.

General Cellular MetriNet Power

System Type	ON Always, Full Power Mode (12V)	ON/OFF, CYCL Mode (12V)
12–24V DC with modem, Backlight ON, SD IN	24 mA + 3 mA/node, ON Always	23 mA + 3 mA/node, ON Cycle 21 mA, OFF Cycle
12–24V DC without modem, Backlight ON, SD IN	24 mA + 3 mA/node, ON Always	23 mA + 3 mA/node, ON Cycle 21 mA, OFF Cycle
12V battery with modem Backlight OFF, SD OUT	6 mA + 3 mA/node, ON Always	3 mA + 3 mA/node, ON Cycle 1.3 mA, OFF Cycle (sleep)
12V battery without modem Backlight OFF, SD OUT	6 mA + 3 mA/node, ON Always	3 mA + 3 mA/node, ON Cycle 1.3 mA, OFF Cycle (sleep)

In addition to the *Cycle* mode setting, the MetriNet can be ordered with either the 12V DC battery board or with the 12–24V DC DC/DC isolated converter board.

The 12V DC battery board is not isolated and is intended for use with only an external 12V DC battery pack. It provides the optimum power savings from battery packs.

The 12–24V DC converter board is intended more for line power continuous operation systems. It provides maximum protection from external power supplies, isolation and allows a wider range of input voltage. This continuous power option consumes considerably more power and is therefore not really intended for battery usage.

NOTE: When power is first applied to the instrument, the modem powers up and configures itself, so current consumption is high. If making active current measurements, you must wait about 2 minutes after power is first applied to see the true steady state current.

NOTE: Battery powered systems run from 12V DC down to about 7V DC. The controller does not contain a power switch. It operates as soon as DC power is applied. Once power is applied, the system goes through an initialization routine and then begins to operate.

Power in 115V AC Unit

In this version of the panelized MetriNet, Badger Meter adds its own AC/DC power supply to the panel. The MetriNet itself utilizes the DC/DC converter and power is not critical, so it is assumed the unit is set for continuous operation. Maximum power is about 6W or 52 mA @ 115V AC.

Power in 12–24V DC Unit

In this version, the MetriNet generally consumes the same amount of base power continuously. This mode of operation is based on the 12–24V DC converter version to provide isolation, maximum spike/surge protection and a wide input voltage range. Although base power is continuous, there is a brief increase in power during a cellular transmission. The user frequency of that transmission does affect average power.

- **A-Run Power (backlight ON)** – At 12V DC, the MetriNet consumes 24 mA + 3 mA/node.
- **B-Modem Power** – At 12V DC, the modem consumes 100 mA for a few minutes at each call.

Assume the user sets the modem to upload all data twice per day. The modem therefore consumes about 100 mA @ 12V DC for 2 minutes on each call. This intermittent modem transmission power over 24 hours can be added to the base power to get the average continuous power.

- Average power of “pulsed” 100 mA modem twice per day for 2 minutes – 3.33 mW per day.
- Average power of base run mode with one sensor (27 mA × 12V DC) – 324 mW per day.
- Total *average* power = 3.33 + 324 = **327 mW, or 27.3 mA average @ 12V DC.**

You can see here that the modem power at only 2 uploads per day has very little impact on the total average power of this system. Even doubling the number of call-ins to 4 times a day has very little impact on power increase. Each additional sensor adds 36 mW to the average power calculation.

Power in 12V DC Battery Unit

In this mode of operation, the MetriNet consumes maximum power only when it is “awake,” and then only a small amount of power when sleeping. The system sleeps most of the time. Backlight is OFF in this mode, and SD card is removed. To calculate power, you need to determine the “average” power over time using the user set cycle settings.

The following example is based on a 15-minute cycle time (*Poll Rate* is 15 minutes). This system is also available with a flow solenoid, so this is included in the calculation.

- **A-Sleep Power:** At 12V DC, sleep current for the entire system is extremely low at 1.3 mA DC, so about 15.6 mW. Sensors are not powered at all during *Sleep* mode.
- **B-Run Power (backlight OFF, no SD installed):** At 12V DC, run current for the entire system is about 3.5 mA + 3 mA/node, but that power only appears for 30 seconds every 15 minutes.
- **C-Solenoid Power:** At 12V DC, the flow solenoids are pulse driven for only an instant (2A @ 200 ms) to change state. The solenoid is used to limit water loss.
- **D-Modem Power:** At 12V DC, the modem consumes 100 mA max for about 2 minutes max at each call.

Assume user sets the following cycle settings on a system with one sensor:

- Modem uploads twice per day (not shown in [Figure 9](#)).
- *Poll Rate* is 15 minutes. Sensor power-up and measurement rate.
- PU delay 30 seconds. On time of sensors once powered up.
- Solenoid delay 30 seconds. Wait time after solenoid changes state.

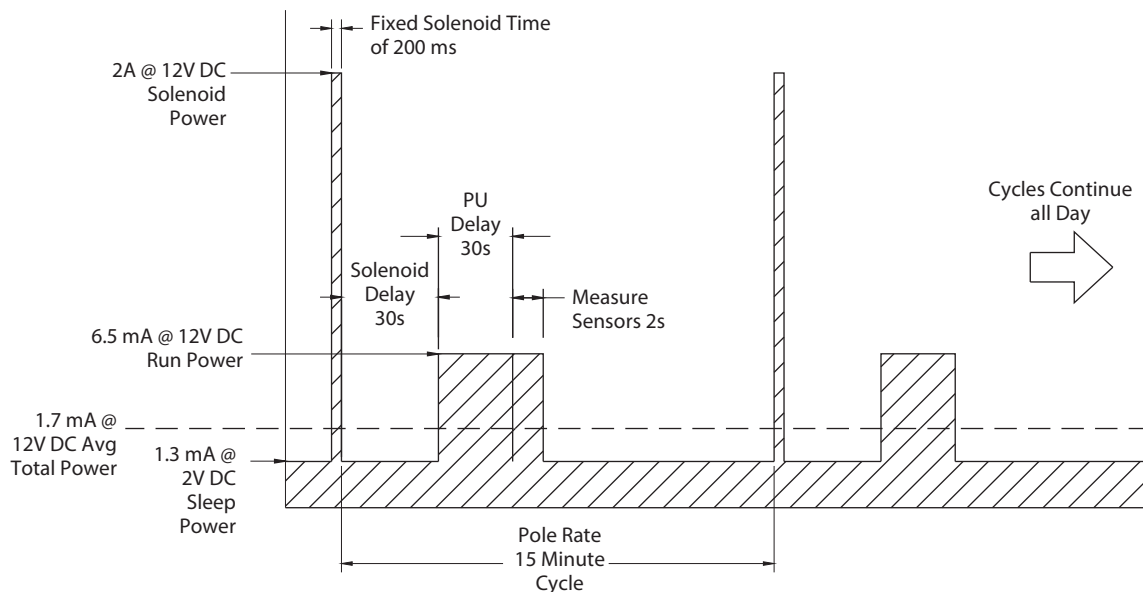


Figure 9: Average vs. pulse power and state diagram

Average power of “pulsed” modem calling in twice per day for 2 minutes – 3.33 mW per day.

Average power of 30 second “pulsed” run mode w/1 sensor – 1.2 mW per day.

Average power of 14 minutes of *Sleep* mode (1.3 mA × 12V DC) – 15.6 mW per day.

Total average power = 3.33 + 1.2 + 15.6 = **20.1 mW or 1.7 mA DC average @ 12V DC.**

Battery Pack Sizing

For the cycled battery mode MetriNet, the calculations of [“Power in 12V DC Battery Unit” on page 16](#) can be used to estimate the size of the battery required for the desired run time.

For example, one of the variations of the MetriNet is available directly with 8 common alkaline D-cell batteries, each with 19 Ahr of available power. This represents a power source of about 12V DC @ 19 Ahr total. $19000 \text{ mAh} / 1.7 \text{ mA} = 11176 \text{ hours}$, or about 465 days – **roughly 16 months of operation on this 8-cell battery pack with the settings in [“Power in 12V DC Battery Unit” on page 16](#).**

Realistically, over a year of operation can conservatively be expected under the following conditions:

- Battery power board installed
- 12V 19000 mAh power source
- LTE-M modem (standard)
- Cycle mode operation, backlight OFF, no SD installed
- One sensor
- Calling in only twice per day to upload all collected data
- Measuring for only 30 seconds every 15

Adding sensors, increasing the number of uploads per day or increasing the frequency of measurement all have an impact on power usage over time. These deviations can be roughly calculated using the information above.

For example, using all the same settings, adding two more sensors (3 total) increases average power by an additional 2.4 mW, which ultimately reduces battery run time to 416 days vs. 465 days. **Powering up sensors longer, and uploading more often, have the biggest impact on power consumption.**

Installation Site Factors

While things like the number of sensors can be easily adjusted in the power calculations above, as well as the frequency of call-ins and the actual cycle measurement time of the sensors, modem signal quality does play a large role at some point. You can see with two call-ins per day, the 7.5 mW average power from the modem is about 10% of the calculated total power. So increasing call-in frequency has a much bigger impact to the lower average power of the cycled system.

However, another thing that cannot be easily shown here is the quality of the cellular connection, often related to distance to the nearest cell tower. If the cell modem has a difficult time calling in, the MetriNet automatically does two things:

1. It retries three times and then simply continues to log data until the next scheduled call-in. No data is lost. At the next call-in, it tries again three times, and continues the process.
2. It automatically adjusts modem cellular transmission power in an attempt to overcome weak signals.

Although collected data is protected, these efforts dramatically increase call-in attempts and can consume a lot of battery power. To prevent these problems, the site should be evaluated carefully during installation to determine good cellular quality. In addition, the MetriNet reports cellular signal strength and battery level in the area in the uploaded data file, so you can quickly see that connections are a problem in a particular location and adjust position when necessary.

CELLULAR SETUP (OPTIONAL)

SIM Card Installation

MetriNet controllers equipped with cellular modems require a SIM card with data service from a national or global service provider.

NOTE: Ordered systems are delivered with a Badger Meter global SIM card already installed, tested and ready to operate. Information on installing the SIM card is provided in case the SIM card must be changed for some reason.

NOTE: For long term installations, you may continue to lease data service from Badger Meter as part of the cloud data plan, or you can arrange your own data services from another supplier. If you want your own SIM card, install your SIM card into the MetriNet modem assembly, and re-configure using the "[MetriNet M-Node PC Software Utility](#)" user manual. In those cases, alternative SIM cards must support the LTE-M service. Be aware that it is very difficult for Badger Meter to troubleshoot issues with non-Badger Meter SIM cards.

1. To install a SIM card, turn off power and loosen the four enclosure screws to access the inside of the controller.
2. Disconnect power and communication cables.
3. Remove the antenna from the controller.
4. Place the front of the controller assembly face down and remove the 4 corner screws holding the terminal board in place.

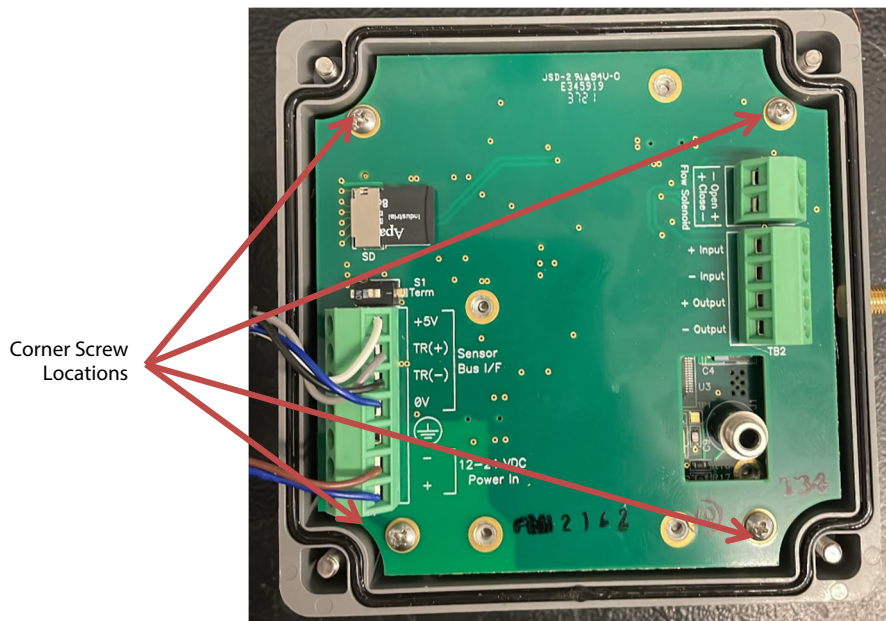


Figure 10: MetriNet rear panel SIM access

5. Carefully unplug the terminal board/modem assembly from the display board by pulling straight up on the green terminals.

6. Turn the terminal board over to access the modem as shown in [Figure 11](#).

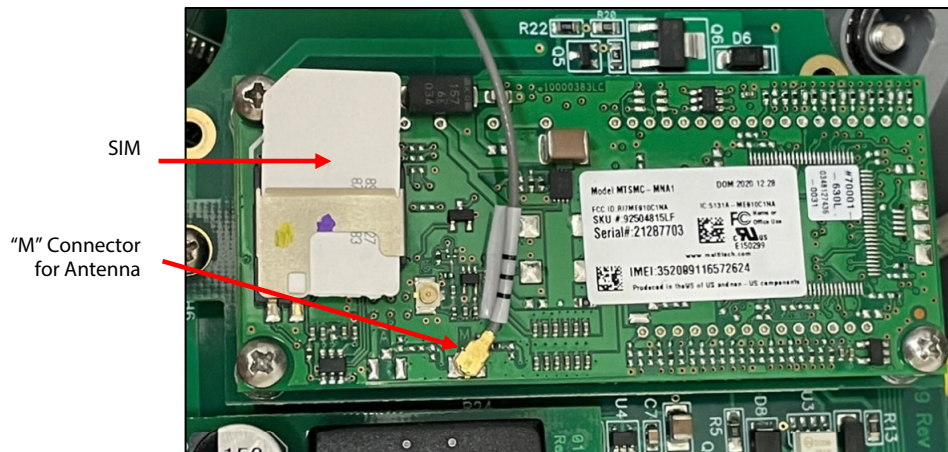


Figure 11: MetriNet cellular modem board with SIM card

7. Remove the current SIM and install your new SIM card. Be careful not to disconnect the antenna cable.
8. After installing the SIM card, plug the terminal board/modem assembly back into the display board. If you carefully line up the four corner screw locations with the standoffs on the display board, the multi-pin connector between the two boards aligns properly. If the antenna cable gets disconnected, be sure to plug it back onto the connector labeled "M" (main), not "A" (aux).

CELLULAR CONFIGURATION UTILITY

General

The Q52/MetriNet is fully tested and shipped already connected to a BEACON® cloud account. Information is included here only if there are connection issues to be resolved, or if you are using your own SIM card or your own data site.

The Badger Meter Q52 Utility is a PC application program used to setup and configure the MetriNet Cell Modem option for a specific customer application. It also includes diagnostic troubleshooting capability required to assure proper operation or to monitor operation should a problem occur.

Requirements:

- Windows based PC
- FTDI-232R-3V3-AJ USB Communications Cable

Install the Badger Meter Q52 Utility software on your PC by clicking on the Badger Meter Utility.exe file. The program is available at www.badgermeter.com. Follow the instructions when prompted to install the program. When you install the utility, it creates an executable file in your Program Files directory. You should find an entry in your directory that looks like this:

"C:\Program Files (x86)\Analytical Technologies\ATI Q52 Utility\ATI Q52 Utility.exe"

Cellular Modem Programming

MetriNet systems supplied with cellular modems may already be programmed at the factory to transmit data to a cloud site where the information can be viewed, stored and downloaded to your computer via the web. You can direct data to a site other than the preconfigured site provided that your alternate site supports FTP transmission, as many cloud storage sites do.

Redirection of modem data requires that the modem be reprogrammed using the Badger Meter Q52 Utility program. A special cable for connection between the modem and a USB port on your computer is included with each MetriNet controller that contains a cell modem option. This cable has a USB plug on one end and an audio plug to the modem on the other.

NOTE: Wait until the serial cable from the PC is plugged into the modem option before powering up the Q52 instrument.

When the modem sees the cable connected, it stays powered up. Otherwise, the modem option powers down when not sending data, and you may get a communications error.

1. Plug the USB cable into a USB port on your PC. The first time you do this, it may take a few minutes to install the device driver.
2. Plug the other end of the serial cable into the jack on the PCB inside the monitor as shown in [Figure 12](#).

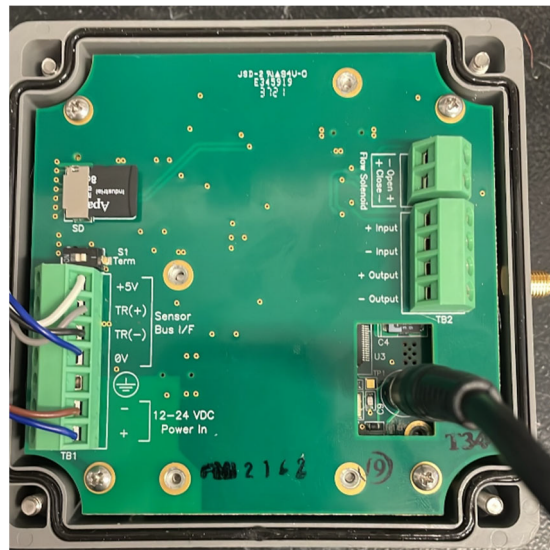


Figure 12: MetriNet PC cable connection

- When the device is ready for use, click the **ATI** icon to start the program. The *ATI Splash* screen displays, then the following window opens.

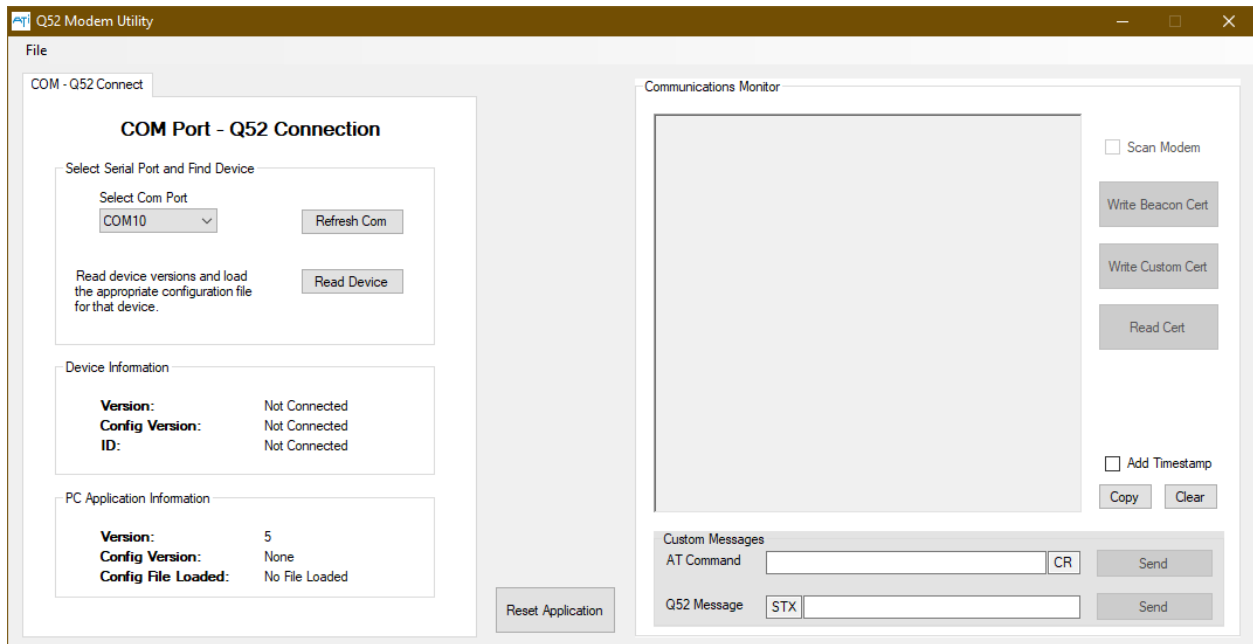


Figure 13: Q52 Modem utility connection screen

- Click the **Refresh Com** option. The program searches for all available Com ports.
- Click the **Com Port** drop-down list and select the Com port for the USB cable. If not sure which Com port it is, unplug it and click **Refresh Com**. Plug the cable back in and click **Refresh Com** again to see what new port appears.
- When the port is selected, click the **Read Device** button. The program attempts to communicate with the Cell Modem.
- Click the **Read All** button. The PC queries the device and displays the current setup/configuration settings as shown in [Figure 14](#).

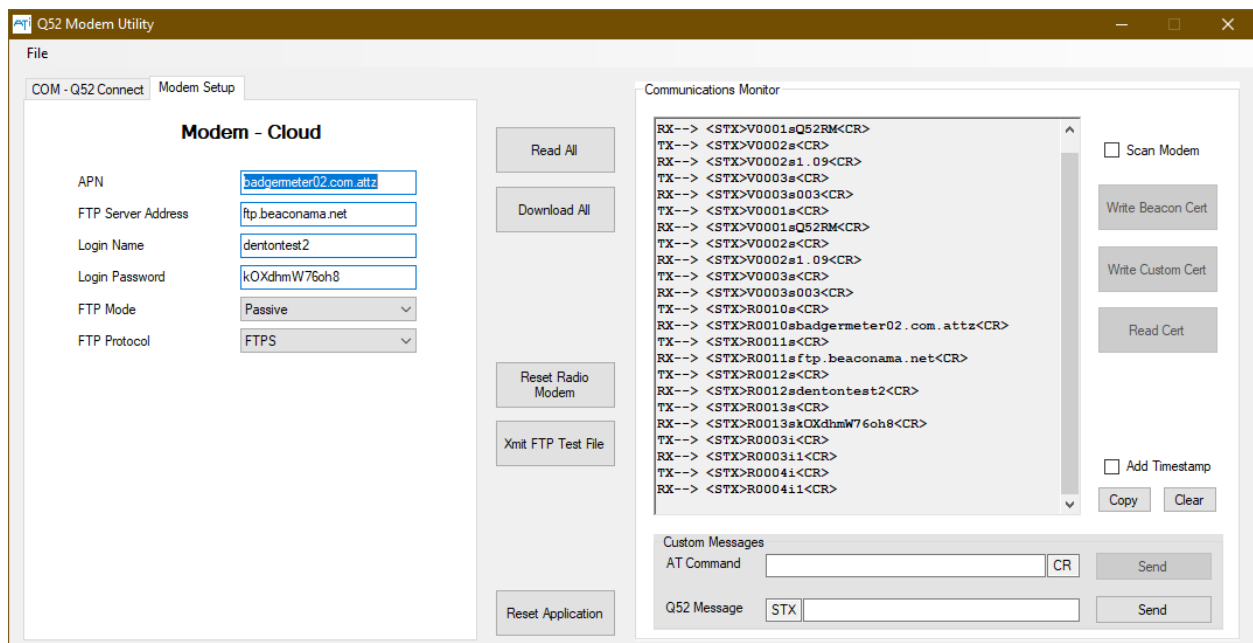


Figure 14: PC Utility config APN screen

- APN** Access Point Name. This varies depending upon your data plan provider.
BEACON® connection with US AT&T SIM: badgermeter02.com.attz.
Custom SIM Card: APN must be obtained from service provider.
- FTP Server Address** The address of the website where the data is being sent. This may be up to 40 characters in length.
BEACON connection: ftp.beaconama.net.
Custom connection: Determined by cloud-based site.
- Login Name** Unique name for each MetriNet and is required by the site for connection. The name may be up to 40 characters in length.
BEACON connection: Device Name from BEACON setup (unit serial number is standard).
Custom connection: Set by customer.
- Login Password** Unique password for each MetriNet and is required by the site for connection. The password may be up to 40 characters in length.
BEACON connection: Automatically set during BEACON setup (must be obtained during setup).
Custom connection: Set by customer.
- FTP Protocol** FTP or FTPS depending on the server.
BEACON connection: FTPS required.
- NOTE:** FTPS requires a server certificate for authentication that needs to be uploaded to the modem.
See the [“Security Certificate Update”](#).

8. After all setup/configuration data has been entered, click the **Download All** button. All of the setup data is downloaded to the cell modem and stored in flash memory.

Security Certificate Update

When using FTPS, the internal modem requires a server authentication certificate. This allows the modem to secure communications between the modem and server.

To upload the certificate to the modem, close any open instances of the Q52 Modem Utility. Open a new instance of the Q52 Modem Utility and connect to the Q52 by selecting the correct Com port. Then click **Read Device** followed by **Read All**. After a successful connection, click the **Scan Modem** checkmark.

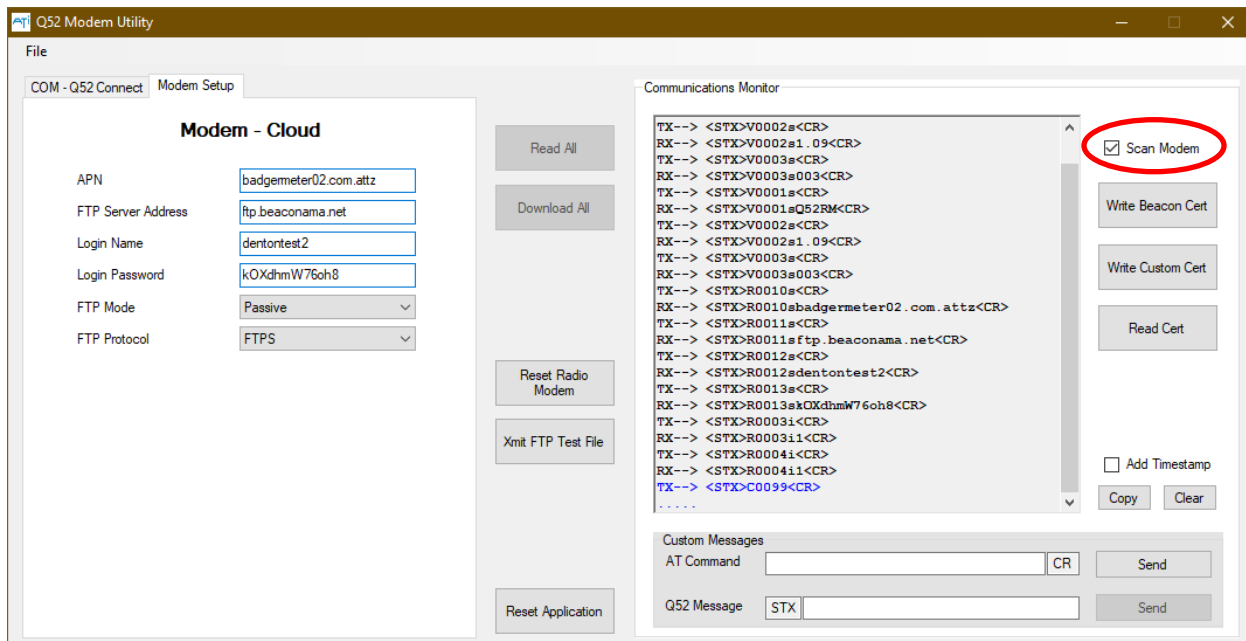


Figure 15: Certificate update scan modem checkmark

The modem monitor either shows that the modem is in use with modem traffic, or it shows “ - ” meaning that the modem is not busy with other communications. This should unlock the certificate read/write buttons on the right.

To upload a BEACON compatible certificate, click the **Write Beacon Cert** button on the right. Most of the buttons on the screen become disabled.

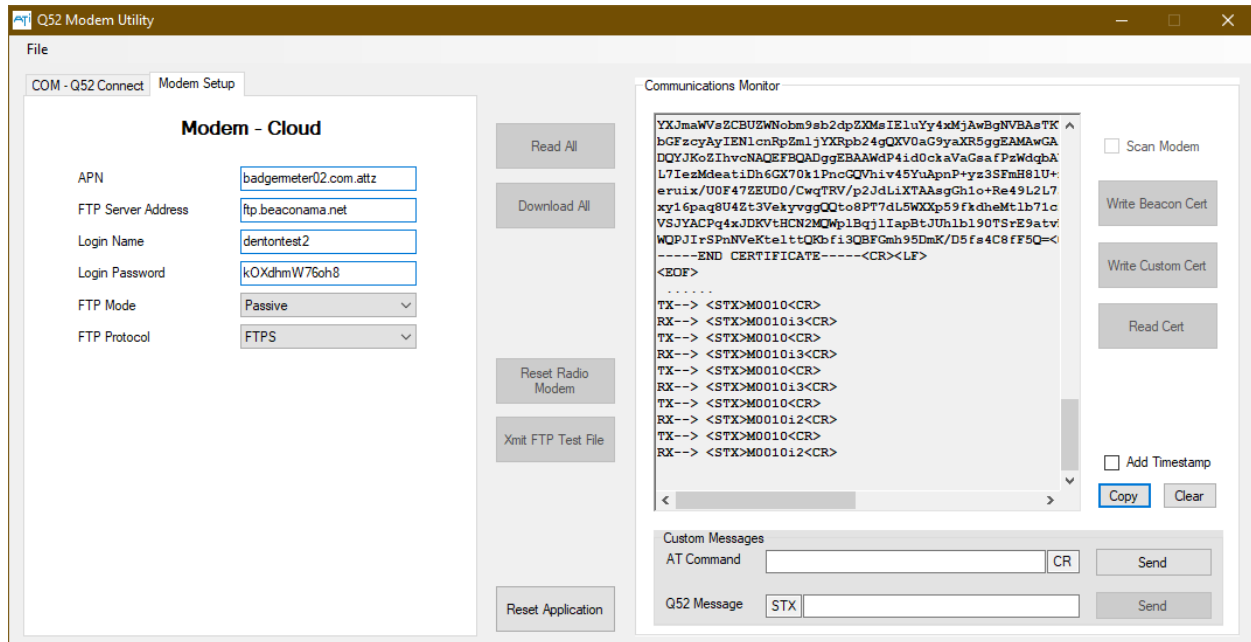


Figure 16: Certificate update write Beacon cert

The certificate write progress is shown in the *Monitor* window – this can take a few minutes. A successful update message appears and buttons unlock.

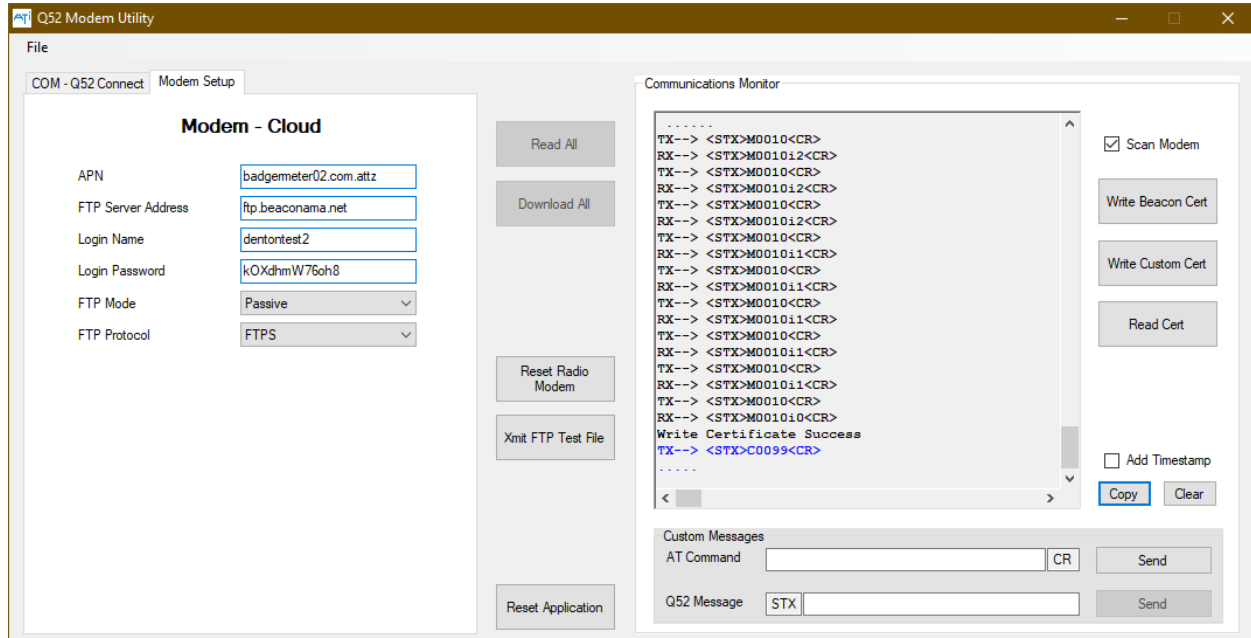


Figure 17: Certificate update successful

If other units need to be configured, it is strongly suggested to close this Utility and restart the process.

Q52/METRINET CELLULAR TROUBLESHOOTING

The following section can be used to correct problems associated with modem communication problems. With the PC utility connected, click the **Tools** option on the menu bar and select **Com Debug**.

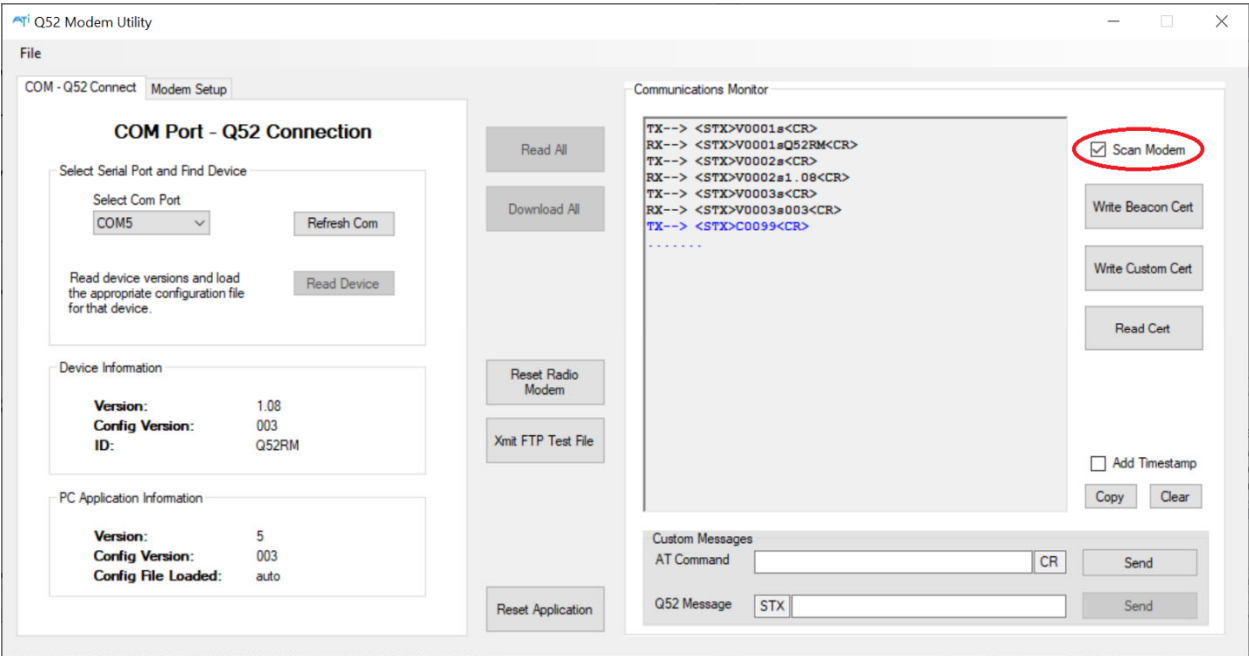


Figure 18: Troubleshooting - MetriNet comm debug feature

An additional window appears. Select the **Radio Data** tab. Click on **Reset Radio Modem**, then click on **Xmit FTP Data**. It takes 6–10 seconds for the radio modem to boot up. After that delay, you should see data appear in the *Radio Data* window. If no data appears, the CPU is not communicating with the radio modem. This would indicate some type of hardware failure.

Figure 19 shows that there is no SIM card installed in the radio modem. When there is no SIM card, data communication to the cell network is not possible. In the example below, the response indicates that an incorrect APN name is entered.

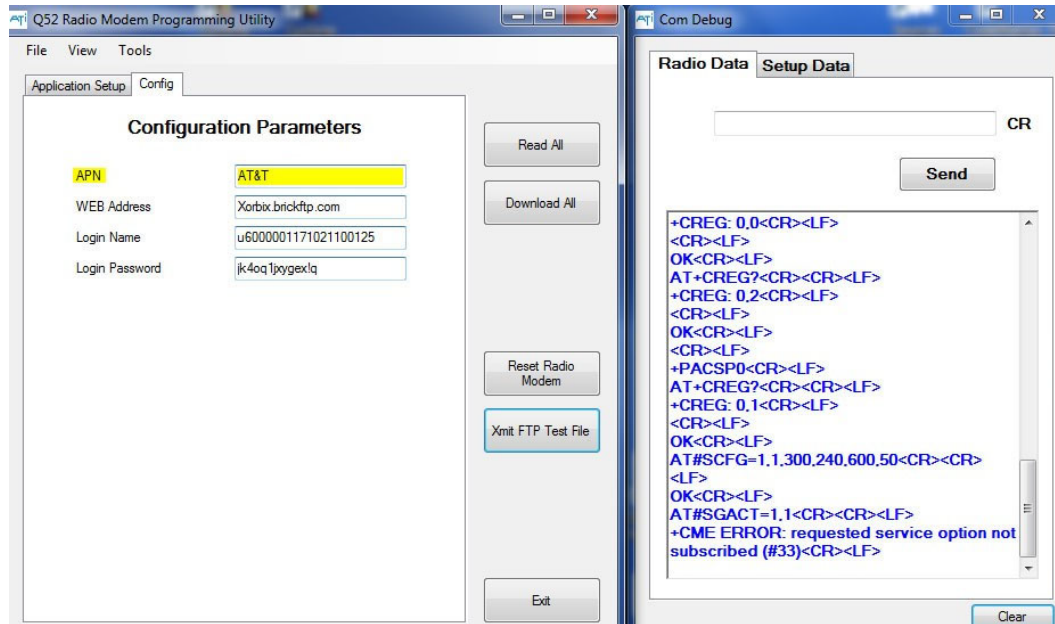


Figure 19: Troubleshooting – radio modem reset

Figure 20 shows that the radio modem is not able to register itself with the cell network. When it begins the process, "+CREG 0,0" displays. When it registers, "+CREG 0,1" displays. A value of +CREG 0,2 or +CREG 0,4 indicates some problem communicating with the cell network. In this case the antenna is not connected to the radio modem. Make sure the antenna is screwed all the way onto the connector, and that the antenna cable inside the monitor is plugged onto the radio modem connector labeled "M."

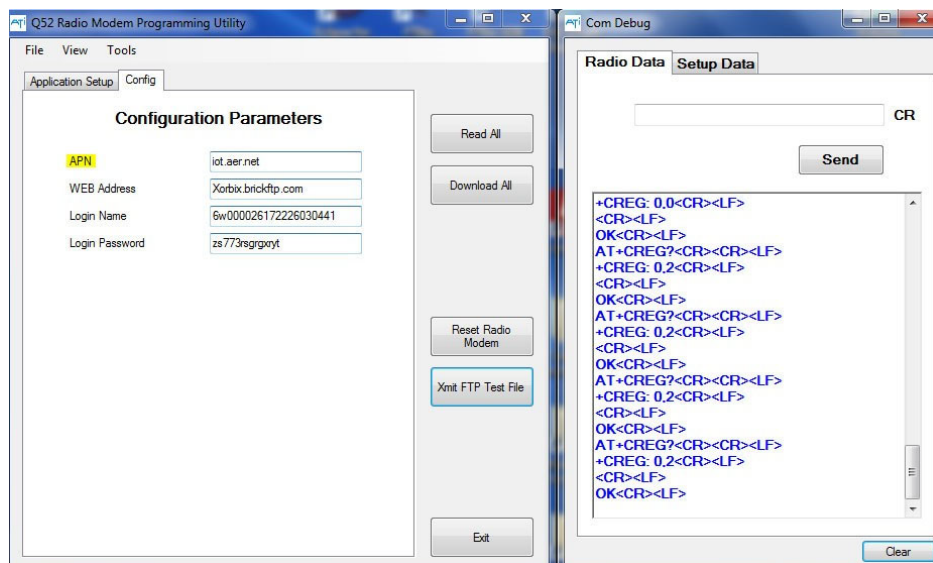


Figure 20: Troubleshooting – modem registration issue, CREG

Figure 21 shows that the radio modem is getting out to the network but having a problem logging onto the file server. If the process hangs at this step, check the WEB address, login name and the login password to make sure they are correct. In this example, the sub domain name is missing from the WEB address.

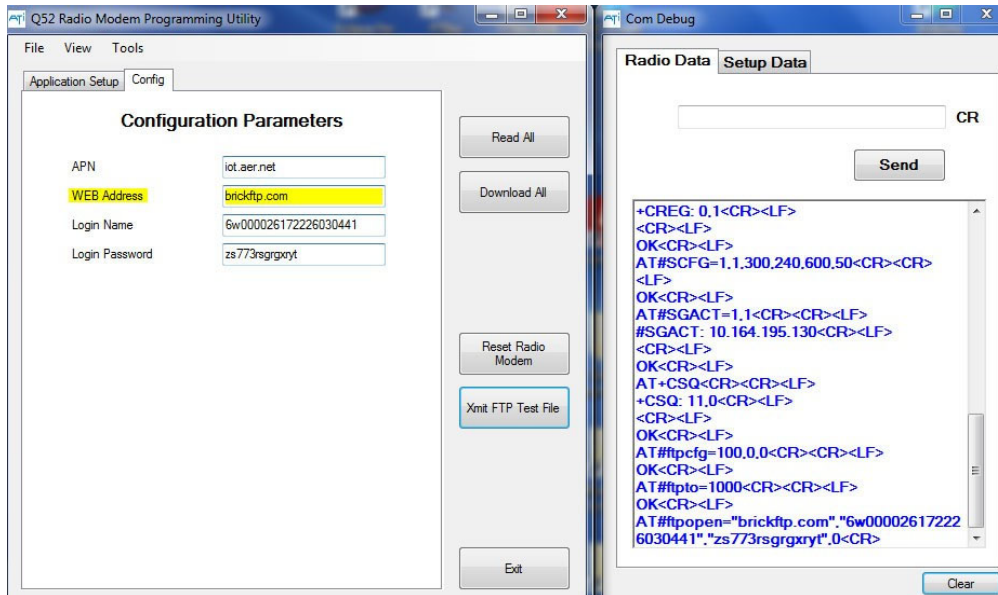


Figure 21: Troubleshooting – cannot log into cloud server

Figure 22 shows the response from the file server where the WEB address is correct, but the login password is not correct.

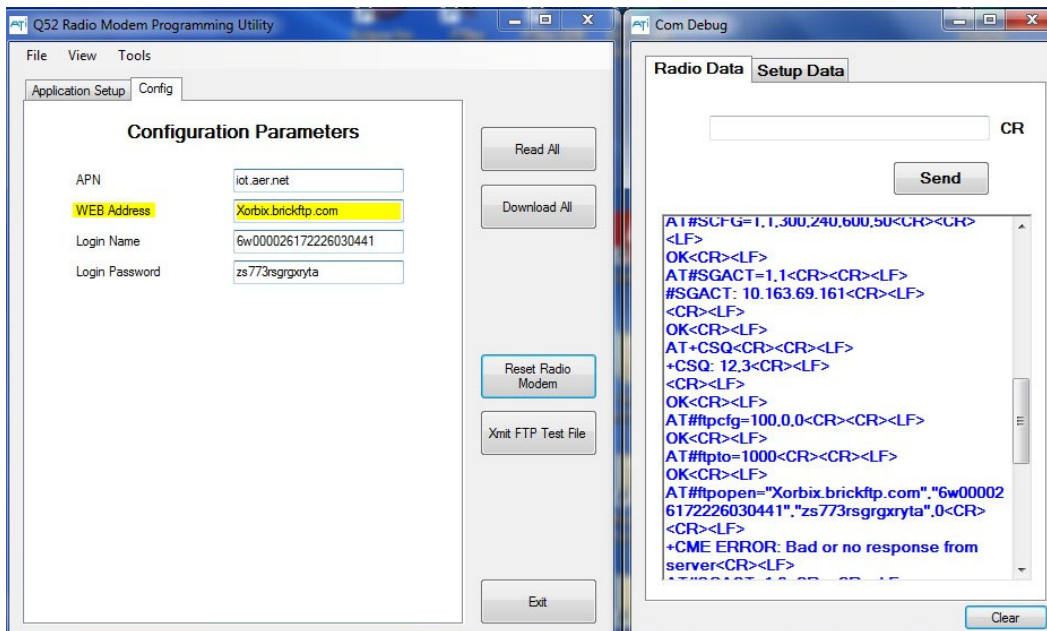


Figure 22: Troubleshooting – possible password issue on cloud server

One bit of data that displays is the signal quality (+CSQ: 11,1) as shown in [Figure 23](#). This indicates how good the connection is from the radio modem to the cell tower. A value of 10 or more is good. Less than 10 may work, but connections may be intermittent, or data transfer may take longer due to the number of retries required to get data uploaded.

The data in this window is absolutely required to aid in diagnosing a communications problem with the radio modem, or between the radio modem and the website. This data may be copied and pasted into an email message or text file to be sent to Tech Support.

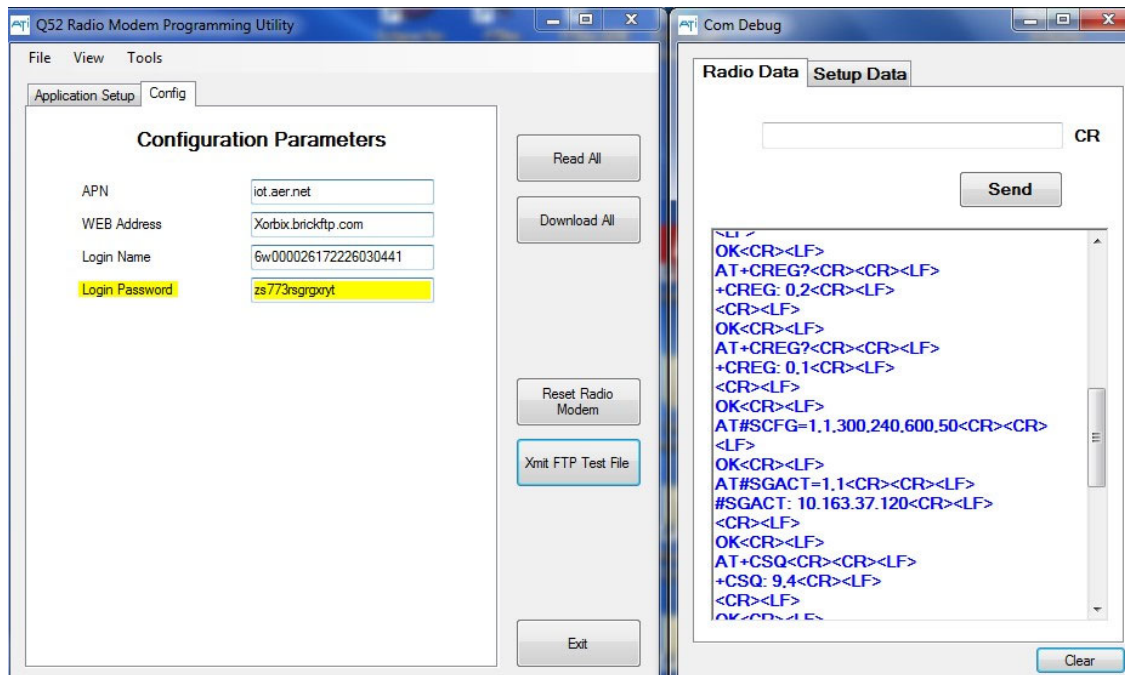


Figure 23: Troubleshooting – CSQ data

